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DOE labs battle problems with disposal, perception of cadmium in solar modules

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Scientists at the Energy Department's National Renewable Energy Laboratory and Brookhaven National Laboratory are working with a leading solar energy company to dispose of waste from its operations — and to counter arguments that some systems to produce energy from sunlight are environmentally unfriendly.

First Solar LLC, based in Phoenix, Ariz., makes solar modules — which are many times larger than solar panels — using a compound called cadmium telluride (CdTe), one of several materials that can be used to convert sunlight into electricity with thin film modules. Cadmium, a highly toxic metal, is a byproduct of zinc mining that is typically tossed on the slag heap or used in nickel-cadmium batteries.

The presence of CdTe in thin film solar modules has sparked criticism from some environmental groups, who worry that toxic substances could be released during disposal of thin-film manufacturing waste and from modules that have outlived their usefulness. They also express concern that CdTe modules could expel cadmium if they catch fire on rooftops.

"It's a perception issue," NREL's Ken Zweibel, manager of DOE's Thin Film PV Partnership Program, said in an interview Monday. CdTe, he said, "has some exceptionally positive qualities. You can't have this [type of thin film] technology without cadmium. It's the key layer [of material] that defines this technology." CdTe and other substances, such as amorphous silicon, make thin film modules a low-cost alternative to more expensive solar technologies, such as the semiconductor-grade crystalline silicon wafers, though thin film systems are less efficient.

Zweibel insisted that CdTe use in solar modules has gotten a bad rap as a toxic hazard. "I've heard everything from 'This is perfect' to 'This is worse than nuclear [energy].' But there is less cadmium in a PV module than there is lead in a PC monitor. It's several thousand times more efficient to use it in a PV module" than in a battery, he said. A thin film module measuring eight square feet contains less cadmium than a single flashlight battery, according to NREL.

Zweibel also pointed to tests conducted in Germany that showed CdTe is unlikely to be released during a residential fire because the flames would not become hot enough to vaporize the compound.

Advocates for thin-film modules maintain that the structures, far from representing an environmental hazard, are a smart way to sequester cadmium by encapsulating it in energy systems that can last outdoors for 20 years or more, and that cadmium is more stable — less likely to be released into the environment — as a compound than on its own.

Still, some environmental organizations have voiced strong opposition to CdTe use. In comments submitted to the California Power Authority last year, for example, Greenpeace activists cited environmental risks from CdTe panels, saying they were "deeply concerned" that the power authority might choose to purchase solar modules "that contain toxic substances."

To counter such opposition, NREL and BNL scientists work with industry and Sandia National Laboratories in promoting thin film technology through the thin film partnership program, part of DOE's National Center for Photovoltaics. Brookhaven runs the center's photovoltaic environment, health and safety project, which addresses such topics as the use and disposal of cadmium and selenium in solar energy systems; the handling and recycling of wastes that never make it into PV modules; and ensuring that PV modules and methods for removing materials from them pass the Environmental Protection Agency's toxic characteristic test. Materials that pass EPA's screening test, known as the toxic characteristic leaching procedure, can be processed or disposed of as non-hazardous waste, which is considerably less expensive than hazardous waste handling and disposal.

Zweibel and his colleague at NREL, Harin Ullal, have joined with Brookhaven researchers to help First Solar launch a CdTe recycling program, in which cadmium is removed from solar modules, recycled and reused in nickel-cadmium batteries. NREL officials said in the future customer returns and end-of-life modules would also be recycled.

First Solar, which along with NREL won an R&D 100 award this year for developing a process that substantially cuts manufacturing costs for thin film modules, uses a technology to process CdTe into "something they can take to a recycler," Zweibel said. The goal of the program is to "have a closed-loop system" for CdTe recycling, he said.

Over the long haul, the paybacks from CdTe use in thin film modules will far outweigh any environmental concerns about the compound, NREL officials maintained: "In the future, using a relatively small amount of cadmium for PV (say, about 2,000 metric tons per year) could change the world's electricity infrastructure," the lab said in one fact sheet. "In comparison, the much larger, existing use of cadmium for other applications (about 20,000 metric tons per year) provides trivial value." — David Jones

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